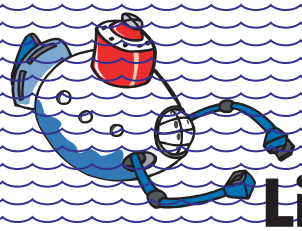

Light at the Bottom of the Deep, Dark Ocean???

Focus

Adaptations of deepwater organisms

Grade Level

9-12 (Biology)

Focus Question

What types of adaptations enable deep-sea fishes to survive and collect food in the darkness of the deep ocean?

Learning Objectives

Students will participate in an inquiry activity.

Students will relate the structure of an appendage to its function.

Students will describe how a deepwater organism responds to its environment without bright light.

Additional Information for Teachers of Deaf Students

In addition to the words listed as Key Words, the following words should be part of the vocabulary list.

Penetrate
Luminescent
Appendage
Dimly-lit
Adaptation
Camouflage
Photic zone
Aphotic zone
Absorption
Wavelength
Spectrometer
Prism
Bioluminescence
Photophores
Mutualistic

This activity requires major adaptations for deaf students as it requires limiting students, vision, as well as use of their hands, both of which are required for communication. However this activity can still be done. If you teach deaf students, use the following modifications to the Learning Procedure.

1. Give students a piece of paper and a pen. Ask students to pretend they are deep-sea animals and have them select which plastic utensil they would like to have as a "feeding appendage" (knife, spoon, or fork). Do not tell the students ahead of time what they will be eating. It is interesting to observe the choices the students make before and after the first trial. Have them write down their choice.

2. Ask for 3 volunteers: one to choose the knife, one to choose the spoon, and one to choose the fork. Use masking tape to attach their chosen appendage to their hand so that they cannot use their hand, but instead can only use the utensil to gather food. Warning! Check the edges of the plastic utensils for sharp edges. For safety, put masking tape over the edge of the knife. Caution the students not to be aggressive with the utensils.

3. Tell the students that they are going to pretend to be deep-sea animals that live in dimly-lit water.

4. Once the students have attached the "appendage" to their hand, distribute the goggles. You should have already covered the goggles with several layers of blue saran wrap or cellophane. The number of layers will depend on how dark the room is. More layers may be needed if your room is very bright.

5. Ask the students to stand around the table. This table should be prepared ahead of time by placing a clean sheet of paper over it. Black or red paper works best.

6. Tell the students that when the light is turned off, they are to scoop up as many Skittles (food) as they can with their appendage (fork, knife, or spoon).

7. Have the first student that is actively participating in this first "round" put on their mask. Distribute Skittles candy evenly across the table. Turn off the lights. A room without windows works best or put black paper over the windows before beginning the activity.

8. Have a set time limit for the students to gather the Skittles and at the end of the time limit, turn the light on. Count how many skittles the student was able to collect. Then let the next student have a turn.

9. Repeat for third student.

10. Allow for discussion between trials and at the end regarding which student was able to collect the most "food" and which "appendage" was the most successful means for gathering food.

11. After the first trial, allow the students to select a different "feeding appendage." This is most interesting because the student who chose a knife at the beginning now understands that they need to be "better adapted" at gathering food and will probably select a fork or a spoon. Most students participating in this activity discover several methods of adaptation for gathering food. Depending on time, you may let all students have a try or limit it to the initial 3 only.

12. Allow all students time for reflection by having each student fill out the answers to the reflection questions on the Student Worksheet. After all students have filled out a Student Worksheet, allow time for class discussion.

13. Ask for a volunteer for the next activity. If all students were not given a chance in the initial activity, choose a volunteer from that remaining group. Allow them to use the spoon as an appendage.

14. Tell the students that when the light is turned off, they are to scoop up as many Skittles (food) as they can with their appendage (fork, knife, or spoon).

15. Have the first student that is actively participating in this first "round" put on their mask. Distribute Skittles candy evenly across the table. Turn off the lights. A room without windows works best or put black paper over the windows before starting.

16. The teacher should be at one end of the table with a flashlight that is turned on and off, so as if to "flash." This represents a viperfish

that uses bioluminescence as a lure to catch prey. It makes for a more interesting time if at the beginning of the game if the other students do not know what the flashing light represents.

17. Flash the light onto the table to illuminate a small portion of the Skittles. The feeding students should be able to see these Skittles better because of the light (bioluminescence). When one of the feeding students approaches the Skittles lit by the flashlight, this student can be grabbed by the student "viperfish," which in turn, "pretends" to eat its newly-captured prey. The student may be grabbed by the arm and made to sit down with the explanation that another fish has just eaten them. Depending on time, you may let all students try this activity and determine whether the added light helps or hinders the collection of food.

18. The demonstration and explanation that follow may be presented before the activity of at the end of the activity. The teacher will demonstrate how a prism can separate different wavelengths of light. Blue, the shortest wavelength with the highest energy, is not absorbed by the shallower waters above and will provide the abundance of blue color at a deeper depth. Green, yellow, orange, and red are the longest wavelengths with the least energy, will be absorbed the quickest, and will not be visible at deeper depths. A spectrometer may be used to demonstrate how scientists evaluate color.

19. Teacher-lead discussion can incorporate:
- Survival of the fittest (knives verses spoons)
- Different types of adaptations enable organisms to capture their prey effectively; learned verses innate ability to get food (some students learned the most effective methods of obtaining Skittles by watching other students)
- Absorption of light in the ocean with depth
- Bioluminescent organs used as a lure to attract prey or attract a mate

Materials

- ❒ 30 of each, plastic folks, knives and spoons - in order for each student to select their choice and to have extra in case some get broken
- ❒ 2 rolls of masking tape – in order to secure a plastic utensil to the student's hand
- ❒ Large clean paper to cover a table – black or red is preferred.
- ❒ Large black paper or heavy cardboard to cover windows, if necessary
- ❒ 1 pair of goggles for each student
- ❒ 1 roll of blue cellophane to cover the goggles
- ❒ 1 roll of Scotch tape to hold the cellophane over the goggles
- ❒ 1 or 2 flashlights
- ❒ Table or other surface, approximately 10-20 feet long
- ❒ 1 or 2 bags of candy Skittles per class
- ❒ Student Worksheet (one for each student)
- ❒ (Optional) 30 snack-size plastic bags per class
- ❒ (Optional) prism

Audio/Visual Materials

None

Teaching Time

One to two 90-minute periods, depending on

the classroom discussion and maturity of the students

Seating Arrangement

Groups of two and whole group

Maximum Number of Students

20 – 25 or as many students that can get around the largest table available.

Key Words

Adaptation
Camouflage
Photic zone
Aphotic zone
Absorption
Wavelength
Spectrometer
Prism
Bioluminescence
Photophores
Mutualistic

Background Information

Deep water reduces the quantity of light reaching it from the surface because once light hits the surface, scattering and absorption rapidly affect it. Light will only penetrate to a depth of 200 meters (the photic zone) and this varies depending on the turbidity of the water. In a depth of one meter, 55% of the light energy has been absorbed. The remaining 45% of the light energy is mostly dimming light of blue and green wavelengths. At about 200 meters depth, in natural light everything under water looks blue because the red, yellow, and orange wavelengths have already been absorbed by the shallower waters above.

Animals will adapt to their environment. Most of the fishes that live in the deep ocean camouflage themselves with red coloration, unlike the fishes that live at or near the ocean's surface that display a variety of colors. Red light is missing in the deeper waters and will not be reflected to a predator's eyes, allowing the potential prey to essentially "disappear" from the predator's site in the dim light.

Sunlight rarely penetrates below 250 meters and this dark water without any light is called the aphotic zone. Many organisms that live here have adapted and generate their own light source through bioluminescence. This light source can be generated in photophores, or light-emitting organs. Some fishes have their own photophores and some "borrow" their light in a mutualistic relationship with luminescent bacteria living on or within the host. Since there is no natural light, living animals use bioluminescence for communication, for attracting a mate, and/or attracting dinner.

Learning Procedure

1. Ask students to pretend they are deep-sea animals and have them select which plastic utensil they would like to have as a "feeding appendage" (knife, spoon, or fork). Do not tell the students ahead of time what they will be eating. It is interesting to observe the choices the students make before and after the first trial.

2. Have students work in pairs. Use masking tape to attach their chosen appendage to their hand so that they cannot use their hand, but instead can only use the utensil to gather food. Warning! Check the

edges of the plastic utensils for sharp edges. The students become excited in the competition, and sharp edges could scratch another student. For safety, put masking tape over the edge of the knife. Caution the students not to be aggressive with the utensils.

3. Tell the students that they are going to pretend to be deep-sea animals that live in dimly-lit water. (Optional: The demonstration and explanation that follow may be presented before the activity or at the end of the activity). The teacher will demonstrate how a prism can separate different wavelengths of light. Blue, the shortest wavelength with the highest energy, is not absorbed by the shallower waters above and will provide the abundance of blue color at a deeper depth. Green, yellow, orange, and red are the longest wavelengths with the least energy, is absorbed the quickest, and will not be visible at deeper depths. A spectrometer may be used to demonstrate how scientists evaluate color.

4. Once the students have attached the "appendage" to their hand, distribute the goggles. Students should cover the goggles with several layers of blue cellophane. This can be done ahead of time to save time during the activity. The number of layers will depend on how dark the room is. More layers may be needed if your room is very bright.

5. Each student should have goggles or they can work in groups of two and share goggles. Sometimes it is more fun for students to observe a partner trying to locate food in the dark.

6. Ask the students to stand around the table. This table should be prepared ahead of time by placing a clean sheet of paper over it. Black or red paper works best.

7. Have each student that is actively participating in this first "round" put on their goggles. Turn off the lights and distribute Skittles candy evenly across the table. A room without windows works best or put black paper over the windows before starting.

8. When it is time to start the "feeding frenzy," tell the students to scoop up as many Skittles (food) as they can with their appendage (fork, knife, or spoon).

9. The teacher or one of the students should be at one end of the table with a flashlight that is turned on and off, so as if to "flash." If a student is chosen to hold the flashlight, review the object of the game with the student first so they understand the role they will play during the round. This student represents a viperfish that uses bioluminescence as a lure to catch prey. (It is important that the other students do not hear you explain this to the student selected to hold the flashlight.) It makes for a more interesting time if at the beginning of the game the other students do not have a clue what the flashing light represents.

10. Flash the light onto the table to illuminate a small portion of the Skittles. The feeding students should be able to see these Skittles better because of the light (bioluminescence). When one of the feeding students approaches the Skittles lit by the flashlight, this student can be grabbed by the student "viperfish," which in turn, "pretends" to eat its newly-captured prey. Continue this process until a few students have been caught. Depending on the maturity of the students, several methods can be used for capturing other students. A student may be grabbed by the arm and made to sit out with the explanation that another fish has just eaten them. All students that are feeding can put their Skittles into a plastic baggy (this would represent their stomach) and then the student pretending to be the viperfish would grab the other student's bag instead of their arm. Depending on the number of students in the class, there could be more than one student pretending to be a viperfish with a flashlight.

11. If students are working in pairs, one student (the observer) stands behind the first one who is feeding. After a few minutes, or when most of the Skittles are gone, turn on the lights and have the students change places.

12. The new group of students should put on their goggles and more Skittles should be distributed on the table. Turn off the lights again and continue play with the new group of students.

13. After the first trial, allow the students to select a different "feeding appendage." This is most interesting because the student who chose a knife at the beginning now understands that they need to be "better adapted" at gathering food and will probably select a fork or a spoon. Most students participating in this feeding frenzy discover several methods of adaptation for food getting.

14. Each time the game is played, the students become more resourceful at collecting food (Skittles). Some students can become too aggressive. For the last trial, depending on the maturity of the students, distribute an entire bag of Skittles on the table and allow all of the students to participate. Stand back and be prepared to turn on the lights in a hurry!

15. If time permits, allow for discussion between trials or have a class discussion at the end of the activity.

16. Allow all students time for reflection by having each student fill out the answers to the reflection questions on the Student Worksheet. After all students have filled out a Student Worksheet, allow time for class discussion.

17. Teacher-lead discussion can incorporate:
- Survival of the fittest (knives verses spoons)
- Different types of adaptations enable organisms to capture their prey effectively.
- Learned verses innate ability to get food (Some students learned the most effective methods of obtaining Skittles by watching

other students.)
- Absorption of light in the ocean
- Bioluminescent organs used as a lure to attract prey or attract a mate

The BRIDGE Connection

www.vims.edu/bridge/biology.html

The "Me" Connection

Have students visit the ocean, either in person or virtually using the Internet, and observe the color. Visit a seafood store and ask the sales clerk where these fish were caught and in what depth of water. Research the characteristics of deep-sea fishes verses surface fishes in the photic zone.

Connections to Other Subjects

English/Language Arts, Physical Science, Chemistry, Earth Science, and Biology

Evaluation

Student Assessment Sheet

Extensions

Have students visit http://oceanexplorer.noaa.gov and follow the Atlantic Bight Expedition 2002 and keep up with the findings.

Research different organisms that use bioluminescence, such as the deep-sea angler, viperfish, squid, dinoflagellates, or others.

Research how light can be produced without heat.

Write a poem about yourself as a deep-sea animal that uses bioluminescence.

Resources

www.biolum.org – Information about bioluminescence

http://www.bioscience-explained.org/EN1.1/features.html – An article written by Dr. Edith A. Widder, Harbor Branch Oceanographic Institution

http://www.sciencegems.com/earth2html

http://www.sci.lib.uci.edu/HSG/Ref.html

National Science Education Standards

Content Standard A: Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Content Standard B: Physical Science
- Chemical reactions
- Interactions of energy and matter

Content Standard C: Life Science
- Populations and ecosystems
- Diversity and adaptations of organisms
- Interdependence of organisms
- Behavior of organisms

Content Standard D: Earth and Space Science
- Structure of the Earth system

Content Standard E: Science and Technology
- Develop abilities of technical design
- Develop understandings about science and technology

Content Standard F: Science in Personal and Social Perspectives
- Population growth

Activity developed by Margaret Spigner, West Ashley High School, Charleston, SC

Student Activity Sheet

1. Which utensil did you choose at the beginning and why?

2. Did you want to change your utensil after the first trial? Why?

3. Which color of Skittles was easiest to see with the goggles on and why?

4. How did the flash of light affect your ability to see the Skittles?

5. Were you attracted to the flashlight beam? If so, how did you feel when you were eaten as prey?

6. What was the purpose of the flashlight?

7. Can you think of any other ways that animals can use a flash of light at the bottom of the ocean?